

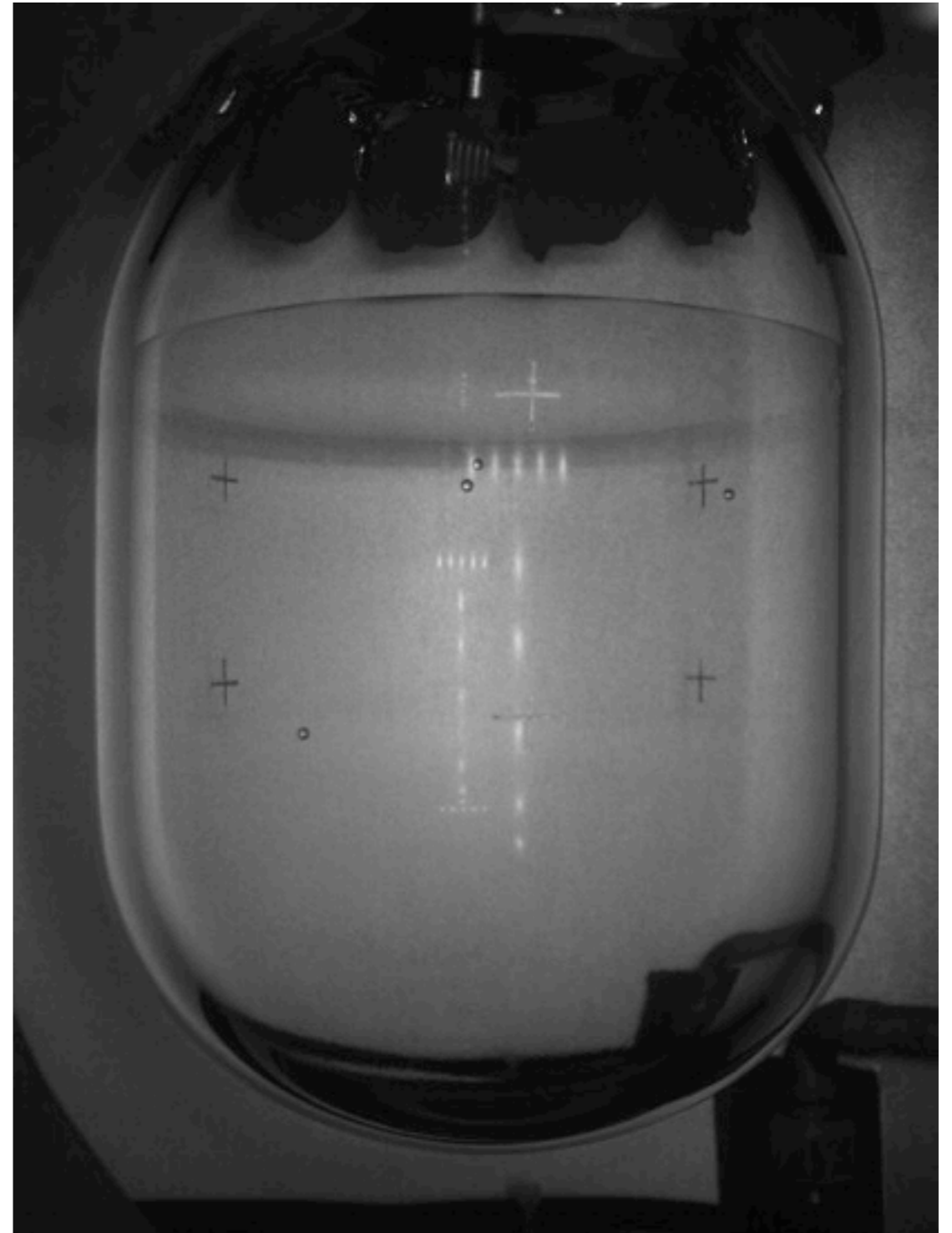
Report from CIRTE (COUPP Iodine Recoil Threshold Experiment, T-1017)

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AEM

April 9, 2011

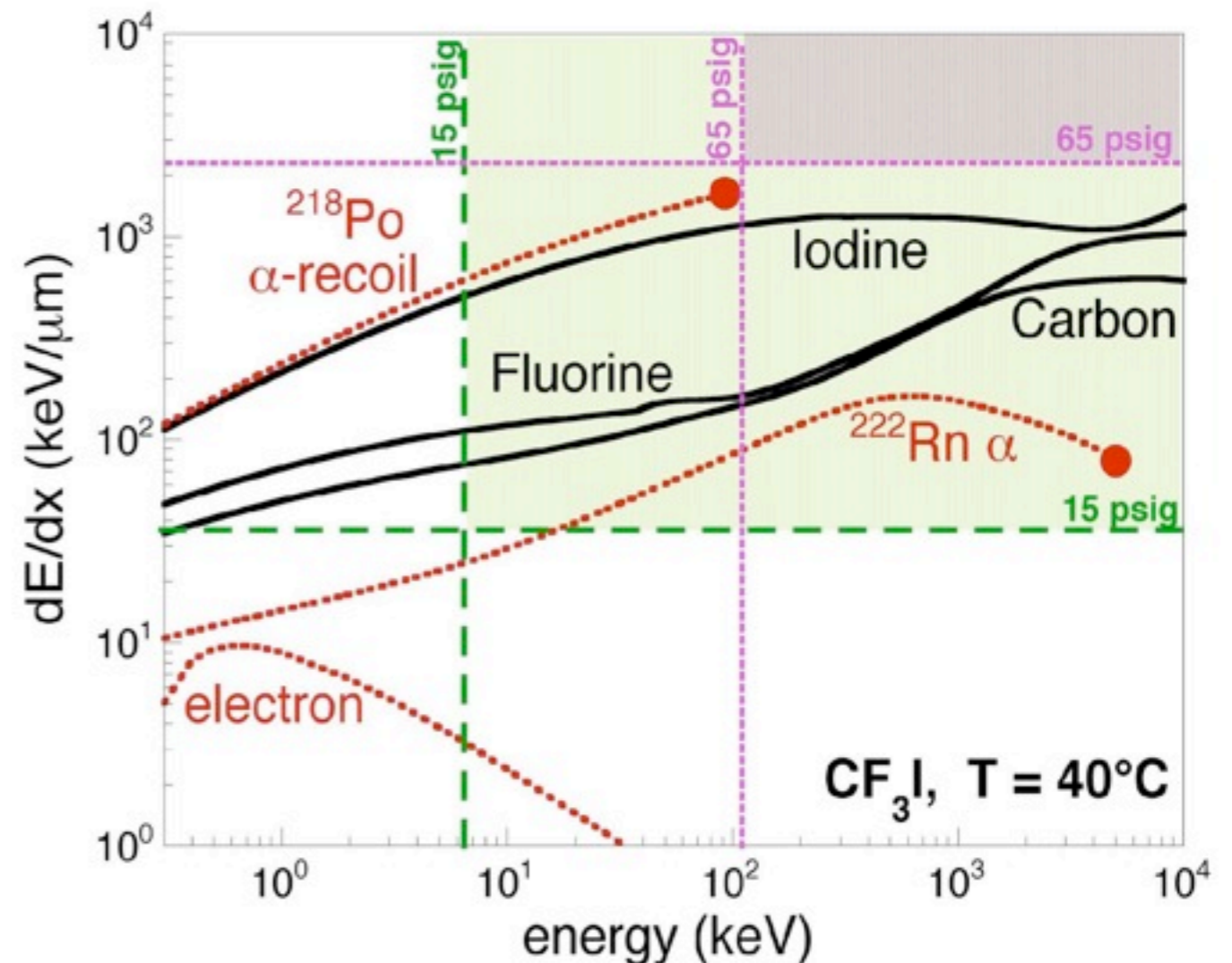
COUPP

- Bubble chamber experiment searching for dark matter
- Dense particle tracks nucleate bubbles in a superheated fluid
- COUPP-4kg and COUPP-60kg running at SNOLAB in Ontario, Canada



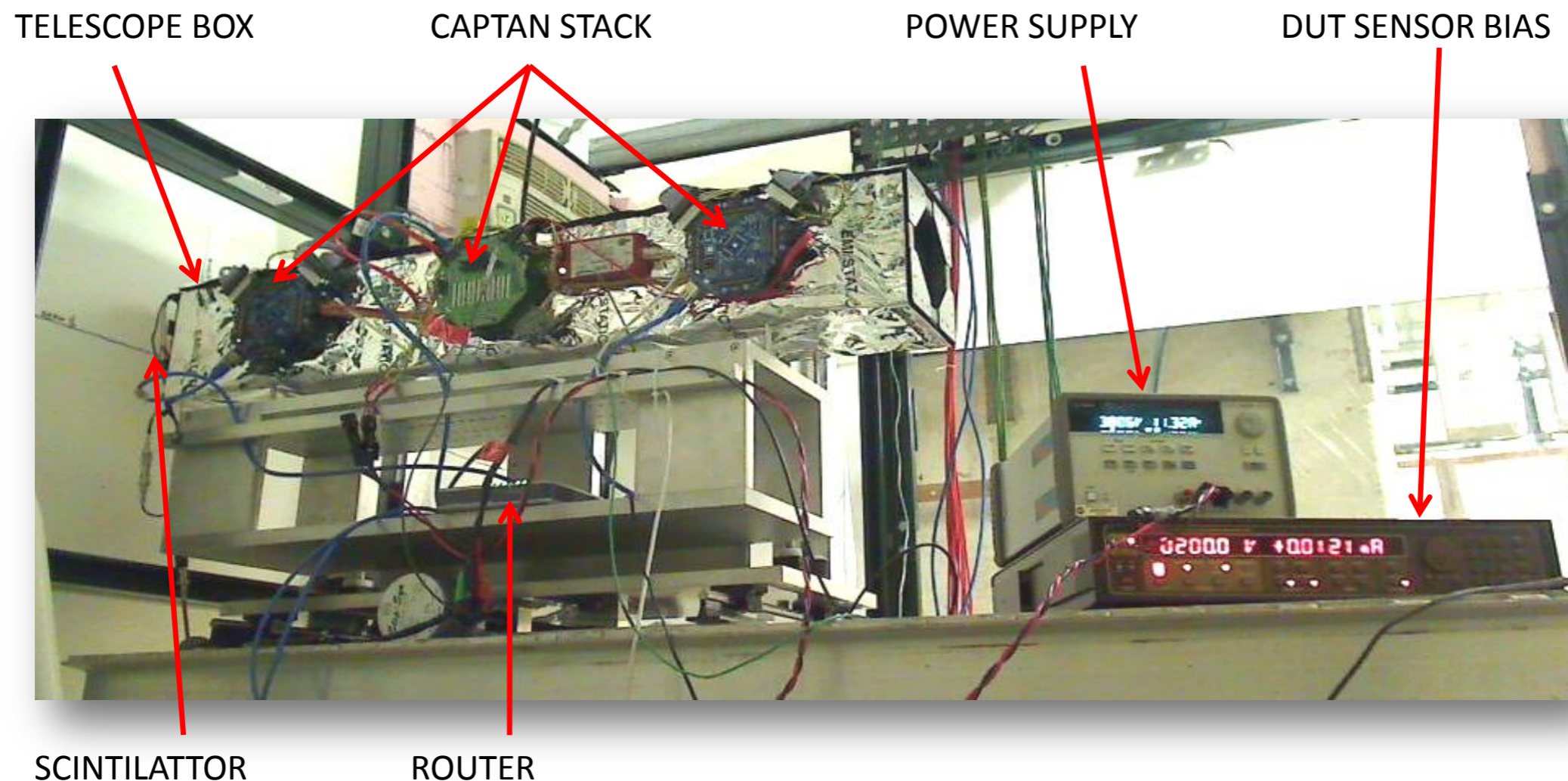
COUPP

- Target fluid is CF_3I
 - Spin-dep (red arrow pointing to F)
 - Spin-indep (green arrow pointing to I)
- Energy threshold given by theory
- Calibrated with neutron sources and alpha decays
- Iodine small component of neutron interactions
- Need for more direct calibration of iodine recoils



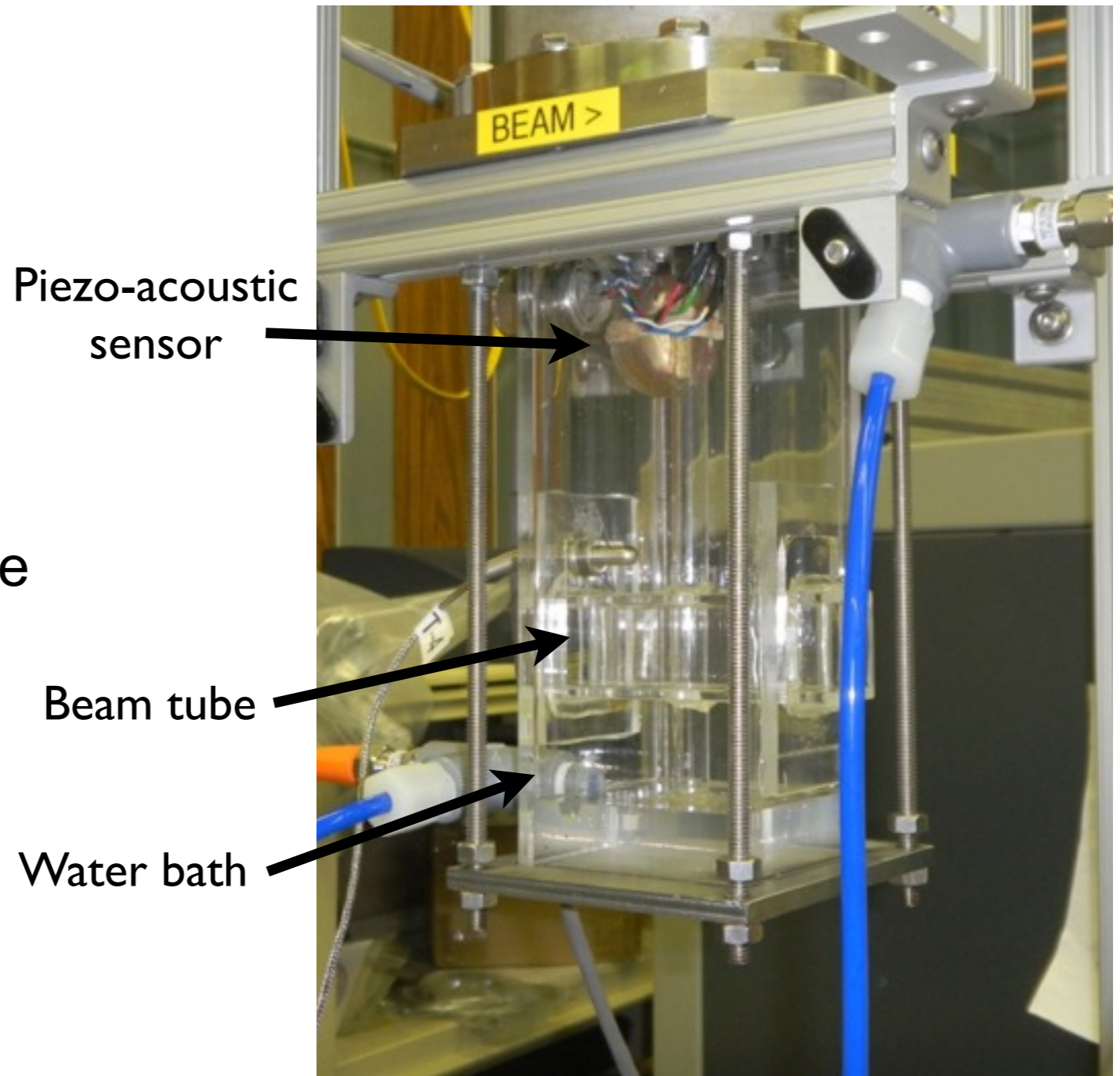
CIRTE

- COUPP Iodine Recoil Threshold Experiment - T1017
- Use elastic scattering of pions to explore iodine recoils directly (window between MCS and carbon and fluorine recoils where iodine dominates)
- Use pixel telescope from Computing Division Detector Instrumentation Group and the Fermilab Test Beam Facility to perform this calibration
- Each telescope track also has a timestamp



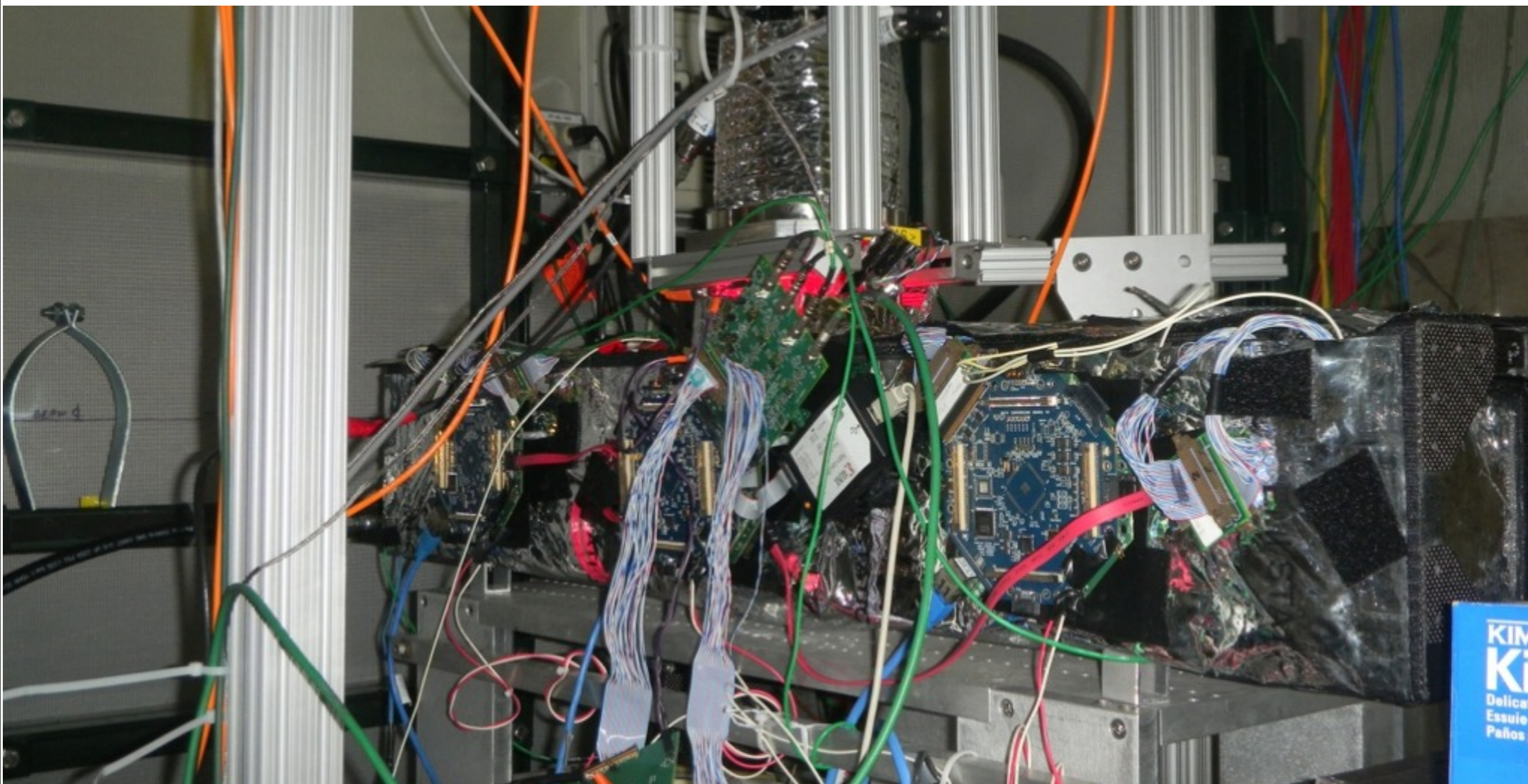
CIRTE

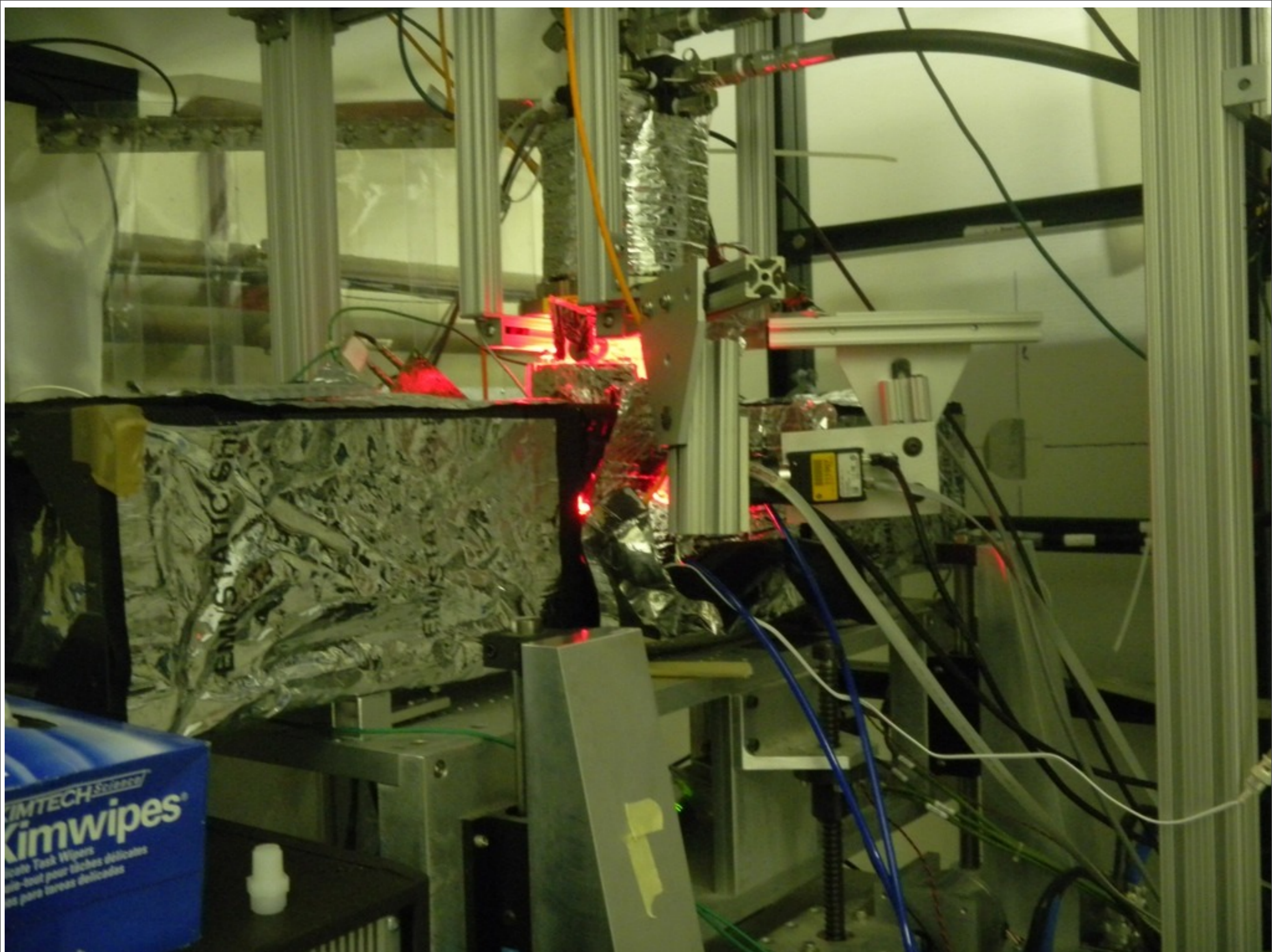
- ~5 ml of CF_3I in test tube
- Temperature control with a water bath
- Tube penetrations to minimize material in the beam
- Acoustic sensor gives the time of bubble formation to within 100 microseconds
- Used to align with timestamps from pixel telescope
- LED array and camera to record the bubbles (not shown)



CIRTE

- Test run from Feb. 7-9
- Physical integration of CIRTE chamber and the telescope
- Test of timing
 - Start of supercycle initiates an expansion of the test tube
 - Scintillator signal triggers the pixel telescope and is digitized by bubble chamber DAQ to synchronize the two DAQs
 - Chamber is then compressed until the new supercycle
 - 1 event per minute
- Observation of first beam nucleated bubbles
- Ended with technical failures in the joints of the water bath, the beam tube penetrations and the test tube





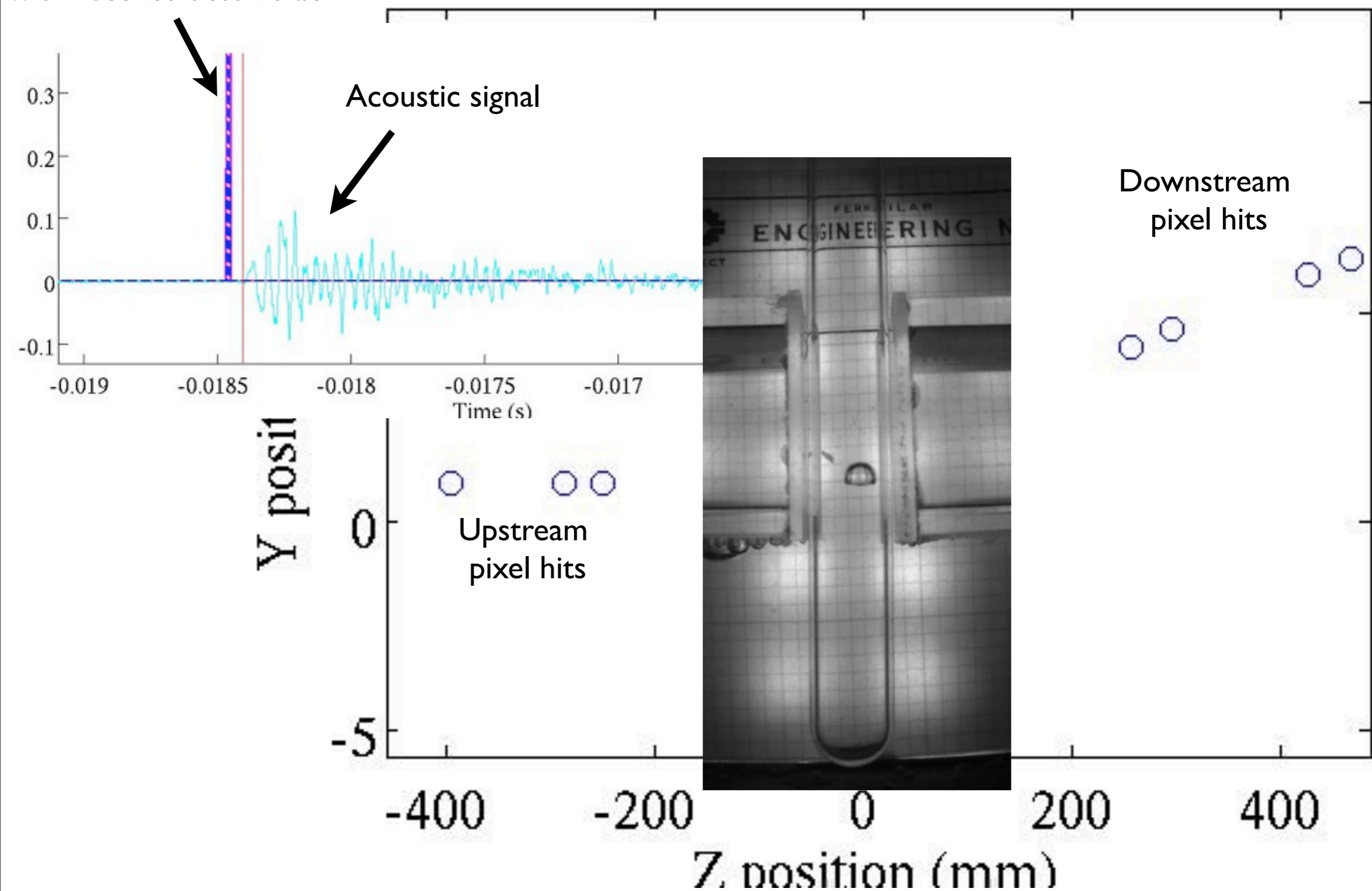
Monday, April 9, 2012

CIRTE Run, March 14-28

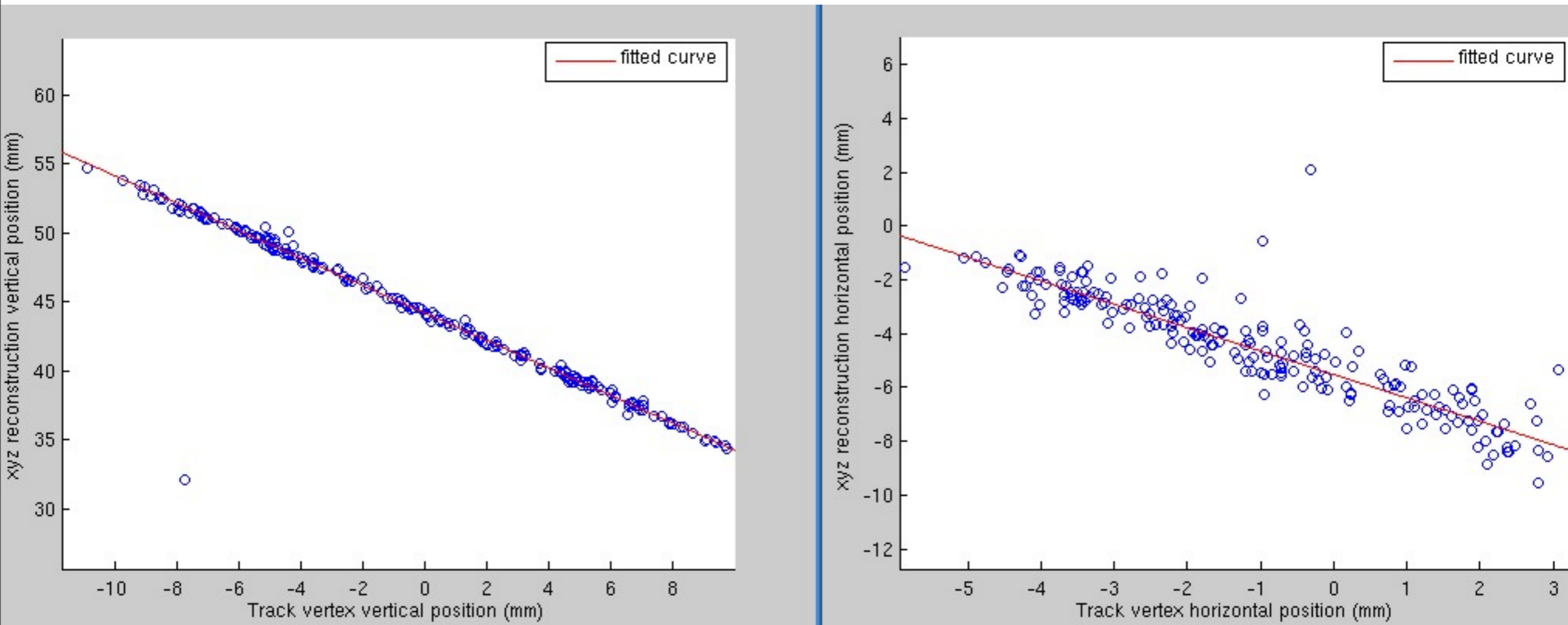
- Improved water bath design (Thank you to Gaston Gutierrez as well as Dave Erickson and Wojciech Blaszyński at MAB)
- Improved stand for ease of installation (Thank you to Cary Kendziora and Ron Davis)
- Installed on Wednesday, March 14, first beam at 7 pm
- Achieved geometrical alignment of beam, test tube and telescope by midnight
- Trouble shooting of the trigger, integration of the two data acquisition systems and analysis chain took place over the course of the following week
 - Eventually found a bug through which timestamps and tracks were offset. Once this was discovered, chamber operation became much smoother
- Ran as continuously as possible until Wednesday, March 28 at 4 am (thanks to AD and SeaQuest for 24 hour running)

Example event - 10 mrad, 56 keV

Telescope trigger
with reconstructed track



CIRTE



- Reconstruction and track matching looks very good
- Strong correlation between bubble position from the cameras and telescope vertex position

CIRTE

- Data collection efficiency is low
- Collected 7125 spills with good run conditions at 15 keV
 - Roughly 5-9% produced good, well-identified large angle scatters correlated with bubbles
 - 78% of bubbles appear in the spill (backgrounds, water bubbles in the bath)
 - 66% of events are single bubbles
 - A third of good single bubbles have tracks that scatter out of the telescope (upstream track points to bubble, no downstream track)
 - About a half have no correlated track (particle presumably missed the telescope)
- Collected another 2000 spills at 40 keV threshold

CIRTE

- Analysis is ongoing, but preliminary results are promising
- Many thanks to
 - Ryan Rivera, Lorenzo Uplegger for support with the telescope (as well as Simon Kwan, Alan Prosser, Jennifer Ngadiuba
 - Gaston Gutierrez, Cary Kendziora, Mark Ruschman, Ron Davis, Dave Erickson, Wojceich Blaszyński for providing mechanical support on the bubble chamber
 - Aria Soha, Todd Nebel, Jerry Taccki at FTBF
 - Accelerator Division for beam